CHAPTER 2
ARCHITECTURAL

2-1. General. Buildings should be designed and constructed in accordance with standard practice except that special attention should be given to features listed herein and in TM 5-852-1/AFR 88-19, Volume 1. Special designs and construction techniques are required primarily because of prolonged and extreme cold, permafrost, snow and wind combinations, transportation, equipment, and maintenance problems. Designers must provide a functional building while considering all factors required to provide an environment which will meet the total needs of the occupants and contribute to high morale. In addition to the facility's intended function, consideration must be given to general data discussed in chapter 1. Factors affecting morale and psychological acceptance must be considered. Inside, proper use of materials, fixtures, colors, textures, component arrangement, space, form and style, temperature and noise control are of key importance. Outside, vegetation and landscaping will contribute toward the goal: a total environment which positively affects personnel stationed at the facility.

2-2. Types of construction. Three general types of building construction may be used in arctic and subarctic regions: concrete, metal, and wood. All have advantages and disadvantages. Transportation methods and costs, necessary labor to construct, existing site conditions, material availability, length of construction season, feasible use of prefabricated items, temperature affects on materials, material fire resistance, stability, durability, plasticity, etc., all must be considered when evaluating the type of construction best suited to a particular function and location. All construction shall comply with fire protection criteria established for Army and Air Force projects. The Uniform Building Code (UBC) and National Fire Protection Association (NFPA) codes shall be followed to the extent authorized by the current criteria. Special attention shall be paid to the NFPA 101. Type of construction shall be specified as required in the above referenced fire protection manuals. Selection processes are discussed later in this technical manual.

a. Concrete. Concrete's fire resistant quality is especially important because low temperatures, high winds, and possible water or chemical shortages make fires extremely dangerous. Concrete has a high thermal conductivity compared with insulative materials, therefore thermal breaks must be provided, and thermal bridges avoided. A concrete slab supporting an exterior masonry wall is one example of a thermal bridge often seen in poorly designed buildings. Even with insulation on the wall's inside surface, heat flows through the slab to the wall, is distributed laterally and dissipated to the outdoors. This process effectively bypasses the insulation. Exterior insulation used with no exposed concrete provides a solution to this problem. Other types of thermal breaks are possible, but successful use is difficult. Concrete is durable in arctic climatic conditions because of its inert nature after curing. Surface cracks and air-path porosity will allow moisture to enter the concrete, however, and freezing results in surface spalling. Air entraining admixtures help prevent such surface spalling and provide a more durable finish. All concrete, whether used indoors or out, should be air entrained to protect it from frost damage during construction. Specifications must include adequate cold weather curing, placing, and handling procedures. (See American Concrete Institute ACI 306.) Quality control is difficult to maintain in the field because of inconsistent batching and limited raw material availability. Local aggregates, if available, may require testing with consistent time requirements. The costs of shipping cement, aggregate, reinforcing steel, form materials, and production equipment for cast-in-place concrete, versus shipping costs and equipment to assemble prefabricated concrete members, plus the basic costs of the materials or members themselves and onsite labor, must all be considered when evaluating the use of concrete for construction.

(1) *Prefabricated concrete items.* Factory prefabricated items such as wall, roof, partition and floor panels, columns, and beams should be considered especially for sites where sand, gravel, and water may not be available or would require excessive hauling or processing. The possibility of damage in transit, the suitability of the manufacturer's and site delivery dates, handling capability at the site, and construction time must all be evaluated. Generally, because prefabricated concrete items are bulky and heavy, the only economical transportation is by water. Occasionally, the components are subjected to the severest stresses in transit rather than during or after erection. Differential settlement often occurs with foundations placed on permafrost, however, and can cause problems with precast concrete wall panels. This potential problem

should be considered in the design process. Prefabricated concrete buildings have been successfully utilized for major construction projects in arctic and subarctic regions. Where repetitive patterns can be used, precast concrete panels should be considered for walls and roofs because they have proven more economical than cast-in-place concrete, even at remote sites. Use of a prefabricated system generally reduces construction time. Particular attention should be given to caulking the joints and connections of prefabricated items. Caulking is discussed more fully under TM 5-805-6, and in paragraph 2-6 in this chapter.

(2) *Concrete masonry units.* Characteristics of concrete masonry units (CMU) with added reinforcement are similar to those of concrete construction. Disadvantages of concrete block construction are the relatively high costs of shipping, breakage, labor, and longer construction time. Therefore, these units are not generally used in remote areas. The inherent multiple horizontal joints tend to collect and hold moisture, especially at extremely wet sites. Most types of concrete blocks have to be sealed and painted or covered with another material for weatherproofing. The covering must breathe sufficiently to allow internal moisture to escape. Trapped moisture causes increased deterioration. Over the life of a building, maintenance can become costly. Concrete block construction is more practical when the source of supply is near the building site. Thermal breaks are also required in concrete masonry unit construction [see paragraph 2-2*c*,(4)], but concrete masonry units are inherently thermal bridging. The concrete web between the indoor and outdoor surfaces conducts heat past the holes which may contain either air or insulation. Even special blocks designed to incorporate maximum insulation and minimize the cross section of concrete between the inside and outside are usually not suitable for arctic or subarctic construction. Metal masonry ties between blocks and another masonry layer represent another type of thermal bridge, even when insulation is present. An exterior insulation layer can avoid problems with breaking thermal bridges across walls with masonry. Differential settlement which often occurs with foundations on permafrost can cause problems with CMU walls and this factor should be considered in the design process.

b. Metal. Metal buildings constructed of rigid steel frames or columns and beams with metal siding and roofing may be composed of standard steel products or components prefabricated at the factory and assembled at the construction site. The basic advantages of prefabricated metal buildings include lower cost of manufacturer's stock items (constructed with revisions to meet the arctic wind and snow loads), and erection speed. Stock sizes can be factory-modified to space members or fasteners closer to meet greater wind and snow loading design criteria. If only air transportation is available to remote sites, consideration must be given to the size and weight of members. Many prefabricated buildings require only standard equipment for erection. A positive thermal break (such as cellular plastic or wood isolators installed in compliance with local fire codes, as illustrated in figures 2-1 and 2-2) is required in heated buildings to prevent cold conduction through the structural members. If conduction is present, frost, and ultimately, dripping water, can form on the interior walls. A continuous, sealed vapor retarder is necessary on the warm side of exterior walls in all heated buildings to minimize condensation within the wall insulation.

(1) *Metal frame, siding, and roofing.* Metal frames may be erected rapidly at the site; however, to obtain a given fire rating additional fire-resistant treatment may be required. Covering the surfaces with noncombustible, heat-resistant materials may be necessary. Fastening the siding and roofing to the framing, whether by screws, bolts, or welding, will cause through-metal-conduction problems. Through-metal conduction, and resulting condensation and ultimate frost buildup inside of buildings where such accumulation would create problems, must be prevented or minimized. Minor frost buildup caused by through-metal conduction may be tolerated in subarctic areas, however, for such structures as automotive maintenance shops, heated auto storage buildings, etc. Thermal-break insulation for components is available from most manufacturers but careful selection must be made to assure suitability for arctic construction. Figures 2-1 and 2-2, following page, show how wood or cellular plastic, when installed in compliance with local fire codes, can be used to prevent through-metal conduction. Voids in thermal walls and roofs should either be filled with insulation to curtail the chimney effect, or adequate draft stops should be provided. Metal roofing fastened directly to the steel frame is apt to leak in time as thermal movements stress the fasteners. The newer standing seam metal systems, which are supported on clips with a sliding feature, have improved long-term performance.

(2) *Insulated arctic metal panels.* The advantage of using these panels is rapid field installation. Panels may be used in lieu of separately installed metal sheets, insulation, a vapor retarder, and the interior finish. There are also disadvantages, however: the possibility of damage during transportation and installation;

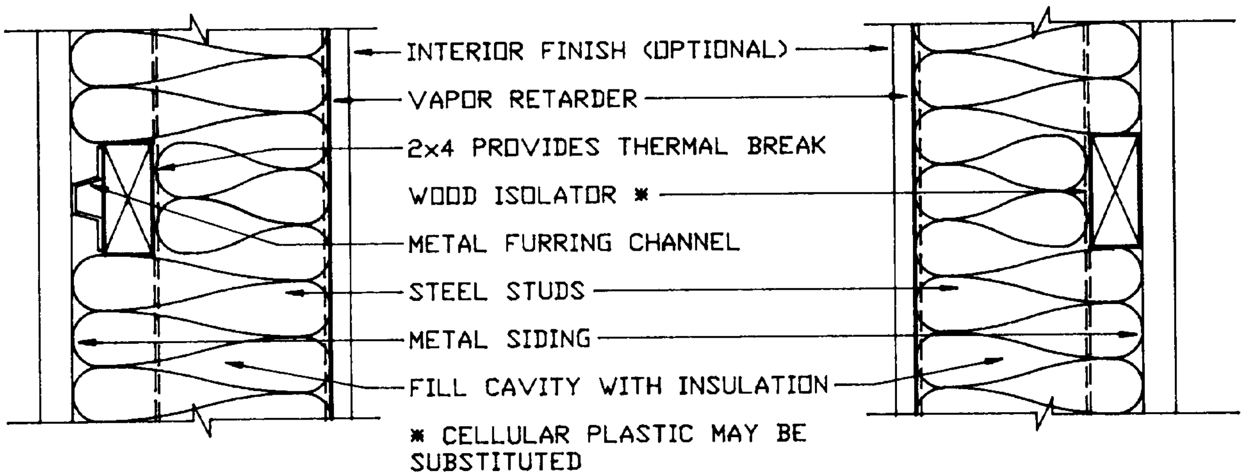
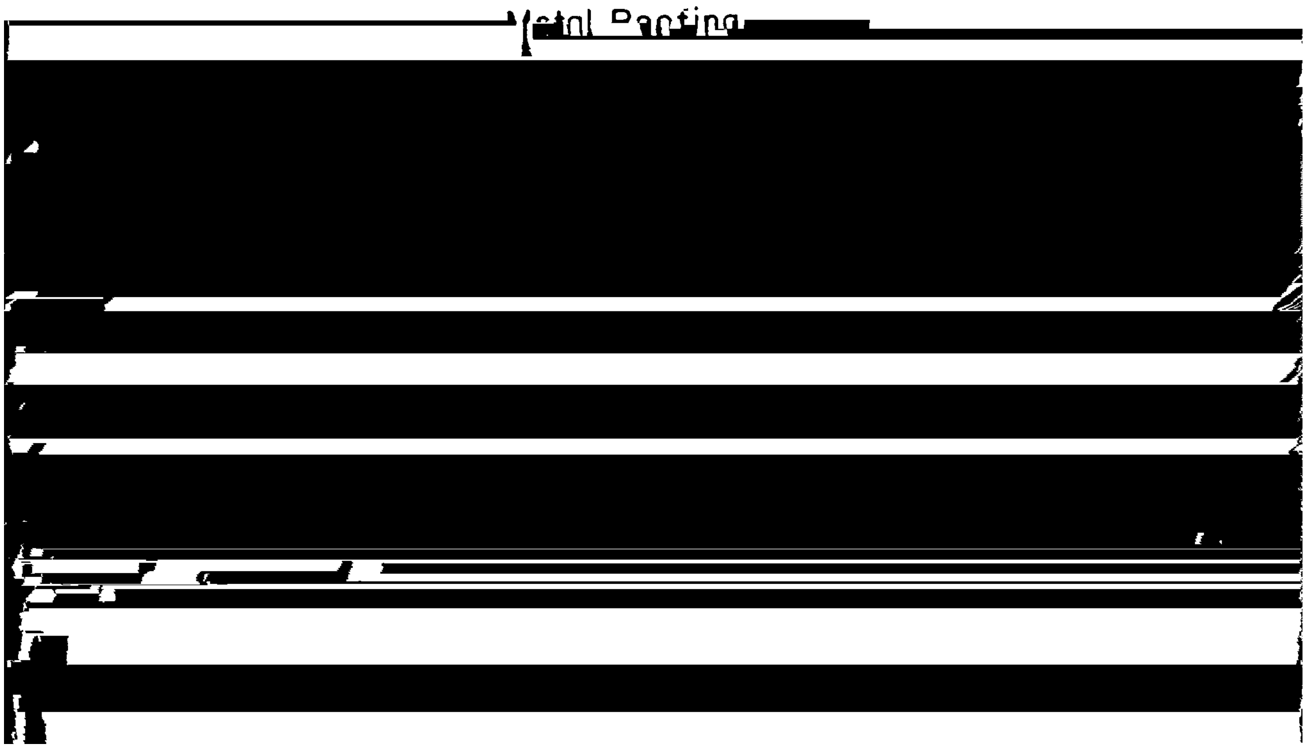


Figure 2-1. Thermal isolator for metal siding.



slow replacement of damaged items; penetration in either or both skins; unsuitable storage; and improper joint sealing between panels. In specifying a panel, the adhesive bond between the exterior metal skin and the plastic insulation must be determined sufficient to prevent delamination over the life of the building.

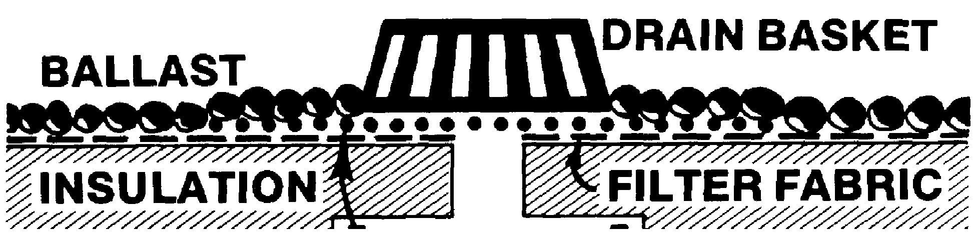
c. Wood framing and siding. Wood frame construction is commonly used in family housing units and in relatively low cost semi-permanent and temporary structures. Wood studs may also be used for interior partitions in other types of construction, provided that the fire codes are met. Metal studs are more commonly used in other building types because wood may require fire retardant treatment.

(1) *Construction.* Wood construction requires fewer technically skilled workers than other types of building materials, and allows extremely wide design flexibility to adapt to special requirements for arctic construction. Wood components may be fabricated at factories or in the field. Proper fasteners, such as screw or ring nails, should be selected to minimize nail popping.

(2) *Fire resistance.* One major problem with using wood framing and siding for building construction in remote arctic and subarctic regions is wood's susceptibility to fire. Heavy timber construction, laminated

wood beams, and arches can burn for several hours without collapsing, however. Wood frame structures are frequently finished with 5/8-inch fire rated Type X gypsum board to provide 1-hour fire-rated construction. Fire-retardant treatments which increase wood's fire resistance should be used on wooden structural members and wood finishes exposed to the interior. Nails, screws, and other fasteners must be compatible with the chemical used in fire-retardant treatments. Intumescent foaming paint may also be used for fire protection, particularly to modify old structures or where other methods are impractical. Non-combustible metal studs are an acceptable and common alternative to wood studs. A thermal break must be incorporated when metal studs are used in a thermal insulating wall, however (see figure 2-1).

(3) *Frost buildups.* Fewer frost buildup problems are encountered in wood frame construction because w



BALLAST
DRAIN BASKET
INSULATION
FILTER FABRIC

e. Temporary roofing. Where it can be predetermined that a complete permanent roof cannot be applied because of weather conditions, temporary roofing should be applied directly to the roof deck. The temporary roofing should not be incorporated in the final roof design.

2-4. Roof slope.

a. Dead-level roofs. Dead-level roofs are not permitted. Water does not drain off of a level roof when the roof drain is surrounded by ice or snow. Also, deflection in mid-span often creates a point lower than the drain. All membrane roofs tend to have inherent shallow ponds that do not drain well without adequate slope.

b. Sloped or pitched roofs. As a result of a report by the Alaska Roofing Board, sloped roofs from 1 on 12 to 4 on 12 have been adopted since 1957. Plate roofs should not be used in cold regions because snow or ice accumulation in valleys causes leaks and other problems. A slope which will provide positive drainage and prevent ponding should be used. A steep pitch on large roof areas produces a high attic which may not be desirable. A slope of 1/4 inch per foot is the minimum recommended for built-up and elastomeric roofing. For protected membrane roofs, the design roof slope should be 1/4 inch per foot to minimize ponding, prevent creep of membrane and pavers, and limit parapet height. The maximum slope for built-up roofs is 3 on 12. The minimum slope for metal roofs is 1 on 12. Regardless of degree of slope, crickets, fill, or similar means should provide positive drainage to roof drains in all directions. Basic roof slopes should be built into the structural roof framing system whenever possible. Tapered insulation has been used selectively to produce adequate drainage on rehabilitation and new projects.

c. Roof drains and gutters. Gutters on eaves and exterior downspouts should not be used on buildings in arctic and subarctic regions because of snow and ice accumulation. In subarctic areas, interior roof drains are normally used on buildings having large roof areas [see paragraph 4-6*b*,(2)]. Whenever feasible, overflow scuppers should be used through the parapet walls. The bottom of the scupper should not be lower than the roof drain. Scuppers should not be located above doorways. If scuppers cannot be provided, overflow drains should be located up-slope from roof drains and connected to a separate drain leader. Overflow drains, however, are not as effective as scuppers and should be used only where scuppers cannot be provided (example: roof area isolated from an exterior parapet wall).

2-5. Exterior painting.

a. General Because of the extreme temperature variations in arctic and subarctic regions, paints should be flexible enough to contract and expand with the substrate. TM 5-618/NAVFAC MO 1 10/AFM 85-3, and the "Steel Structures Painting Manual," published by the Steel Structures Painting Council, are good references. Whenever possible avoid the need for exterior painting by using materials that do not require painting in the field such as natural, pre-finished, or integrally colored materials. Latex base paints perform better on exterior wood than oil base paints because they breathe and thereby allow passage of vapor through the paint which may avoid blistering.

b. Ambient temperature. Exterior paint is usually applied when the structure is nearing completion, often late in the construction season. At this time of year, the night temperatures frequently fall to 40° F and below. Such low temperatures do not allow proper curing, and the result will often be poor adhesion, poor strength, permanent tackiness, or excessive wrinkling. This problem should be considered when planning the construction schedule; for example, the exterior painting could be performed the summer following construction. Paint may be cured during unfavorable weather or temperatures by providing properly heated and vented enclosures where proper curing temperature is maintained.

c. Areas for special consideration. Major paint damage occurs where glaciation forms on exterior wall surfaces from defective eave flashing, around exhaust louvers, and where water vapor leaks from within the buildings. Wall glaciation, which results from melted snow on the roof through defective eave flashing and moisture condensed around exhaust louvers, will cause removal of paint film and unsightly discoloration. The paint film will break and blister on exterior wall surfaces where there is poor water vapor exfiltration control. Moisture penetrates the paint film, prying it loose from the substrate. Designers should consider these problems during design to eliminate the causes of glaciation, or provide finishes that do not require painting, such as glazed structural units, clay tile, stucco, stone, mineral-surfaced colored non-asbestos panels, metal siding with factory finish, CMU, or concrete. Water can get behind and freeze, then dislodge finishes such as tile, stone, etc. This problem should be addressed in the design. Exhaust louvers and fans should be located away from fire escapes, entrances, landings, etc., to prevent glaciation on these areas.

2-6. Caulking. Caulking compounds normally used in temperate regions do not perform satisfactorily in arctic or subarctic areas. The extreme variation between low and high summer and winter temperatures causes common caulking compounds to become brittle and lose their cohesion and adhesion. Caulking materials which can maintain flexibility with permanent cohesion and adhesion at -60° F should be used to caulk or seal joints of precast concrete panels and metal roofing, around window and door frames, and in similar areas. Some sealants which meet these criteria are: butyl, polybutene, and polyisobutylene based sealants; single compound polysulfides, polyurethanes and silicones; and two- component polysulfide and polyurethane based sealants. For additional information on caulking materials and practices, see TM 5-805-6.

2-7. Exterior doors.

a. Exterior personnel doors. Exterior personnel doors are normally free from frost buildup unless there is high humidity within the building. Vestibules or arctic entrances should be provided in particularly high-humidity buildings and windy areas. Typical high-humidity areas are laundry and dry cleaning plants, restaurants, dormitories, swimming pools, kitchen areas in mess halls, etc. Because of high winds and extreme cold, doors located on the prevailing windward side of the building should have special protection (windscreen or baffle) in addition to arctic entrances which are discussed in paragraph 2-10*a*, this chapter. Wind screens, baffles, or heavy bumper stops mounted on steel posts should be provided to protect the doors and hinges from damage and to prevent injury. For energy conservation reasons, arctic entrances are advised at all major personnel doors. For exterior use, metal doors and frames are sturdier, will look better longer, are better insulated, and will retain their shape better than wooden doors and frames. Both doors and frames must be insulated and weatherstripped, and should have an integral thermal break. Seams in doors should be sealed (continuously welded and ground smooth). Many metal doors have the outside skin directly attached to the inside. This type of door is unacceptable because the inside surface efficiently collects heat, which the metal edge then conducts to the outside surface which dissipates it efficiently. When wooden doors are used, they should be solid-core wood stave to provide maximum insulation and warpage resistance. In the arctic, temperatures may range from an inside door surface of 60°F to an outside door surface of -60°F. Exclusive use of insulated metal doors and frames is highly recommended.

(1) *Weather-stripping.* The entire perimeter of all exterior doors should be weather-stripped with adjustable cold weather neoprene or butyl rubber in extruded aluminum holders. This type of weather-stripping retains its flexibility at -60°F. Spring-type or interlocking metal weather-stripping should not be used because they lack durability, particularly because snow or ice clogging can result in mechanical damage. Metal weather-stripping should not be used because it will form a through-metal connection between interior and exterior and ice up quickly.

(2) *Thresholds.* Thresholds should be hardwood or metal with integral thermal breaks to minimize cold penetration. Set the threshold in sealant.

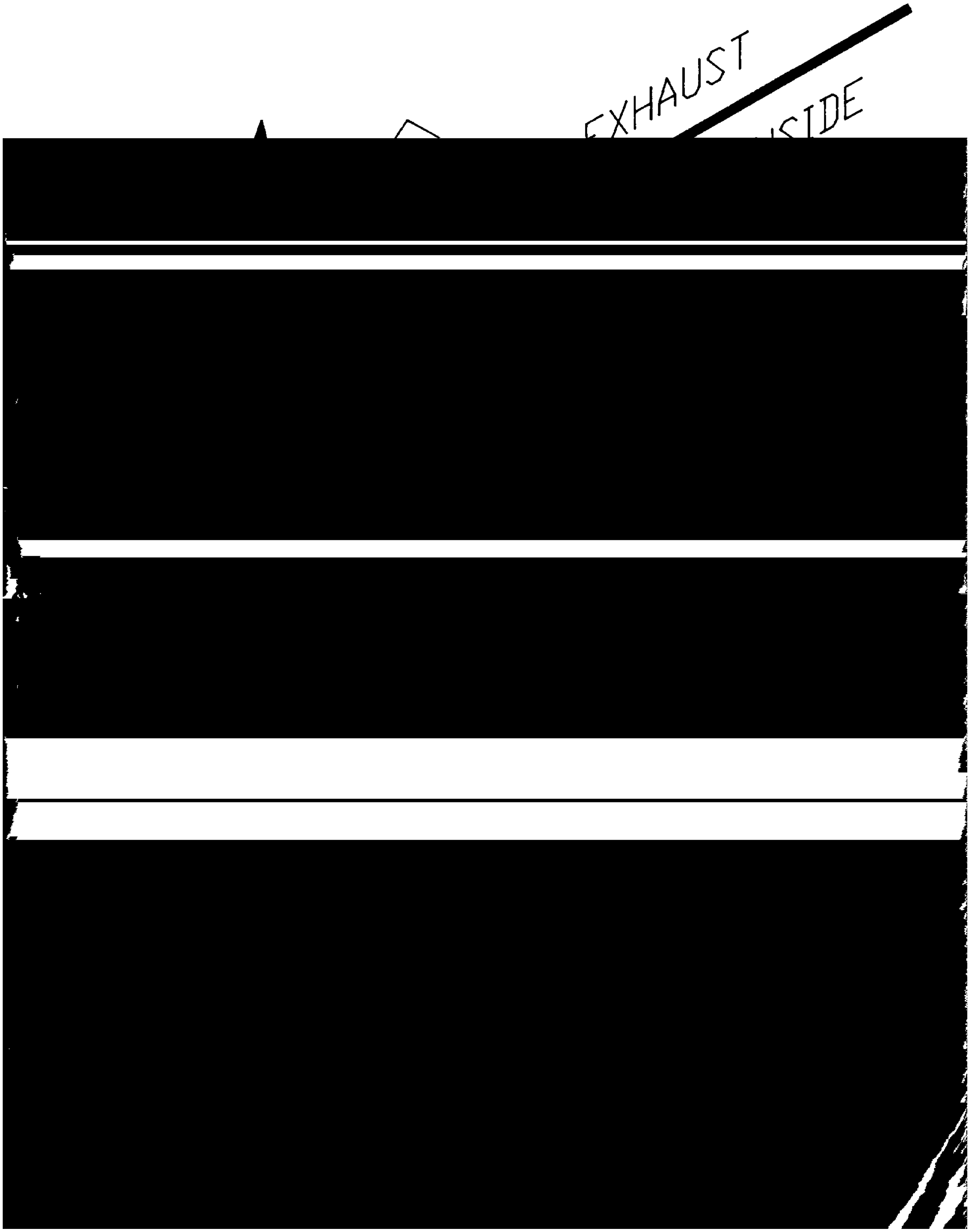
(3) *Locks.* On doors with weather-stripping, cylinder locks or latches should be installed with center line of lock or latch 5 inches from edge of door. Personnel will be able to avoid skinned knuckles, and operate knobs easily while wearing mittens and gloves if this 5-inch distance is maintained. Mortise locks or latches should have lever handles to provide more clearance for hands.

b. Overhead doors. On shop and warehouse buildings where large doors are required, sectional overhead doors should be used. Standard steel sectional doors consisting of sections fabricated from steel panels with a foamed-in-place polyurethane core are available from several manufacturers. The outside and inside panels during the summer. The need for windows should be weighed carefully because there is a lot of unwanted sunlight in summer and cold infiltration in winter. As a rule, window area should not exceed 10 percent of the floor area served by the window(s) in a given room or area. Another factor which must be considered is that continuous daylight during summer months necessitates use of opaque window shades for some functions. If passive solar heating is being considered because of the high heating degree days, however, more windows on the sun exposed side are allowed to achieve this design. The number of operable windows should be held to a minimum to reduce cold infiltration and heat loss. AFR 88-15 requires operable windows in sleeping rooms for use as emergency and secondary exits. Operable window area shall be in conformance with NFPA 80 and 101, and U.B.C. Low air infiltration rate and frames that provide a thermal barrier are essential for window design in cold climates. Windows that do not have these inherent qualities frost up and freeze. The result is an ice buildup which melts and drips, transmits cold air, allows heat to escape, and is most unsatisfactory. Aluminum windows with an integral thermal break and metal clad wood windows (aluminum cladding with baked-on factory finish) are good design choices. Both require minimum maintenance, painting, etc. Vinyl clad wood windows should be specified with caution since some vinyl cladding becomes brittle when subjected to low temperatures. The composite "U" value of approximately 0.54 for units fabricated from both types of materials is satisfactory. The American Architectural Manufacturer's Association's Voluntary Specification for Aluminum Prime Windows, AAMA 101, and the National Woodwork Manufacturer's Association's Industry Standards for Wood Windows, I.S. 2-80, both require the air infiltration rate not to exceed 0.5 cubic feet per minute (cfm) per foot of crack of all operable sash when tested in accordance with American Society of Testing Materials, ASTM E 283. In the arctic, the tested air leakage rate should not exceed 0.15 cfm per lineal foot of crack for a pressure difference of 0.3 in. of H_2O across the window. In the subarctic, the same test should not exceed 0.25 cfm per lineal foot of crack. The gap between the window unit and the rough opening should be thoroughly sealed so that air leakage around the unit won't negate the benefits of a low leakage window.

b. Adding a weather-stripped storm sash to existing windows can improve the U-value of the window system. However, most will not significantly improve the air leakage characteristics of existing windows. When occupants neglect to close storm windows during cold weather, they nullify the benefits of storm sashes. Avoid using windows with double prime sashes, either sliding or double hung, in cold-dry arctic and subarctic regions, because occupants are likely to leave one set of sashes open and nullify the potential benefits of the window design. In wet, windy areas, however, such double sash windows are suitable because they can provide ventilation without allowing water to enter. The occupant simply opens an outer sash such that air encounters a closed inner sash behind it and is diverted sideways to an open inner sash behind a closed outer sash. Modern window units glazed with insulated glass and equipped with effective weather-stripping have been used very satisfactorily on many buildings in the arctic and subarctic to reduce heat loss, condensation, and frost buildup. Triple or double insulating glass, with a single pane piggyback unit in a removable weather-stripped frame attached to the interior face of the sash, should be used in areas that have heating

Table 2-1. Temperatures and Relative Humidities at Which Moisture Condenses on Window Glass
Relative Humidity

No. of Glass Panes:	Double		Triple		Quadruple	
Window Cover?	Yes	No	Yes	No	Yes	No
Outdoor Temperature (Fahrenheit)						


EXHAUST

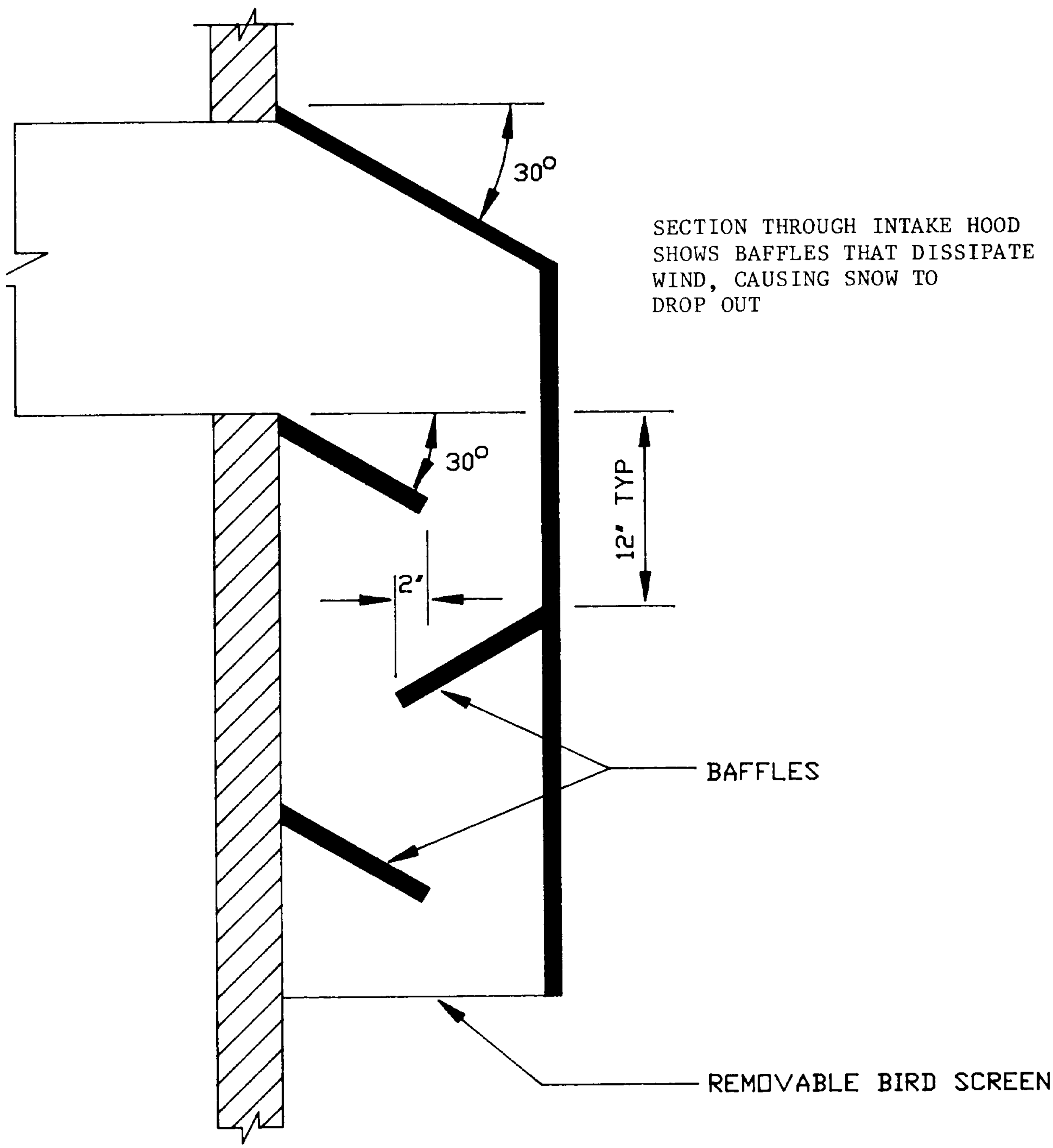


Figure 2-5. Intake hood.

Metal hoods with plywood lining and baffles should be provided to prevent frost accumulation from restricting air flow through the intake hood. During the winter, a slight positive pressure normally occurs in a heated building; therefore, mechanical pipe chases for plumbing in buildings should be sealed to prevent the condensation, in cold attics and on the undersides of cold roofs, that is caused by moisture rising to these areas. To prevent condensation, vent pipes, ducts, rain leaders, and chimneys should be insulated where sections go through the cold attic. All joints in walls and roof should be sealed to prevent snow, wind, and condensation infiltration, particularly if a negative pressure could develop in the building.

b. Vapor retarder. The vapor retarder should be installed on the warm side of the insulation. Vapor retarder materials are normally required to have a permeance not to exceed 0.5. To obtain a continuous vapor retarder, care must be exercised to assure that all joints, corners, and penetrations are completely sealed with properly specified mastic or sealants. Well detailed designs and careful supervision during construction must be provided to obtain maximum retarder continuity between walls and roof. The design should strive to provide a 100 percent vapor retarder. The degree of success is a function of both the material used in construction of the basic structure, and the skill, diligence, and supervision of the workmen applying the vapor retarder. Therefore, design provisions should always be made to assure that the insulation behind the vapor retarder can breathe, that is, rid itself of moisture before excess trapped moisture can develop which would lead to deterioration. There is an economic balance point where the cost of attaining 100 percent vapor retarder has to be weighed against the potential damage aspect from nonattainment. The vapor retarder should consist of a not less than ½-ounce copper sheet, or 2 to 3-mil-thick aluminum foil adhered to heavy kraft paper with glass fiber reinforcing spaced not more than 1/4 inch in each direction, or 4 to 8 mil polyethylene sheet. Polyethylene sheet does not meet the flame spread and smoke development rating listed previously. It may be used, however, if covered by properly designed gypsum wallboard or a fire resistant material. The polyethylene material is considerably less expensive and easier to install than the other vapor retarders, resulting in fewer and better sealed joints and providing a more effective end product.

c. Insulation. Insulation should be provided in walls, ceilings or roofs, and elevated floors to provide the required heat transmission "U" value difference between the interior and exterior surfaces (see paragraph 4-8). Three general types of insulating systems currently being used are: rigid board which is normally used on top of roof decks, in refrigeration plants, and as perimeter insulation at foundation walls; batts or blankets between furring or framing members in walls and ceilings; and insulated panels in sandwich construction. For information on insulation for roof decking see TM 5-805-3 and TM 5-805-14. For typical installation of vapor retarder and insulation see figures 2-6 and 2-7. All exterior foundation walls shall have properly designed (2-inch minimum) perimeter insulation board extending from the top of the footing to the bottom of floor slab. At doors, a preformed joint filler should be used between slab(s) and wall. Depending upon the wall construction, the insulation may be on the exterior or interior face of the wall. If used on the exterior, it shall be protected with metal or other durable finish materials and shall be extruded polystyrene conforming to ASTM C-578, Type IV which has a low moisture coefficient. Type I is acceptable on interior surfaces in areas where the fill does not retain moisture and the water table does not rise up to the insulation level. All insulation shall meet flame spread and smoke development rating requirements, or shall be covered on the interior by properly designed gypsum wallboard, or a fire resistant material.

(1) Spaces between wall framings and door and window frames should be fully and carefully filled with insulation. This not only provides continuous insulation, but minimizes cold air penetration and infiltration.

(2) Blanket-type insulation should be fastened down near the eave vents to prevent it from curling back or being lifted which can block the air flow and reduce the insulation value in these areas. Wire mesh baffles between rafters are often used to maintain vent space (see figure 2-8).

(3) All interior air spaces in the wall cavity should be filled with insulation or blocked at intervals to minimize the chimney effect of air flow within the cavity. This construction helps reduce moisture condensation and freezing in the cavity. Where the air space is not completely filled, all types of insulation must be adequately supported to assure that settlement does not occur.

d. Ventilation. In addition to an effective vapor retarder and sufficient insulation, a building needs adequate ventilation to eliminate indoor pollution, reduce excessive humidity, and bring in fresh air.

(1) *Attic, roof, and under-floor ventilation.* Usually, a small amount of frost or vapor condensation accumulates on the underside of the cold roof even though the ceiling is protected with an effective

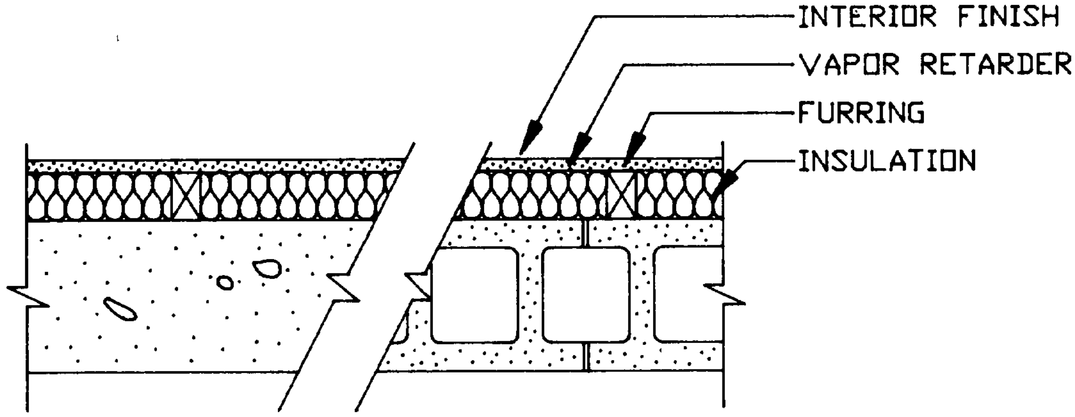


Figure 2-6. Concrete and CMU walls (plan view).

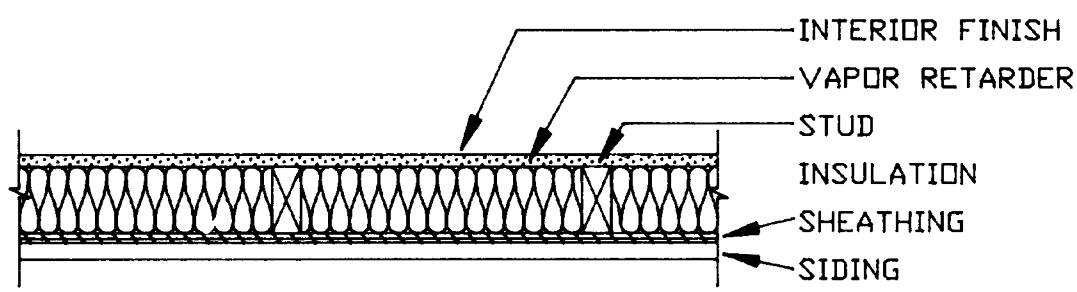


Figure 2-7. Wood frame wall (plan view).

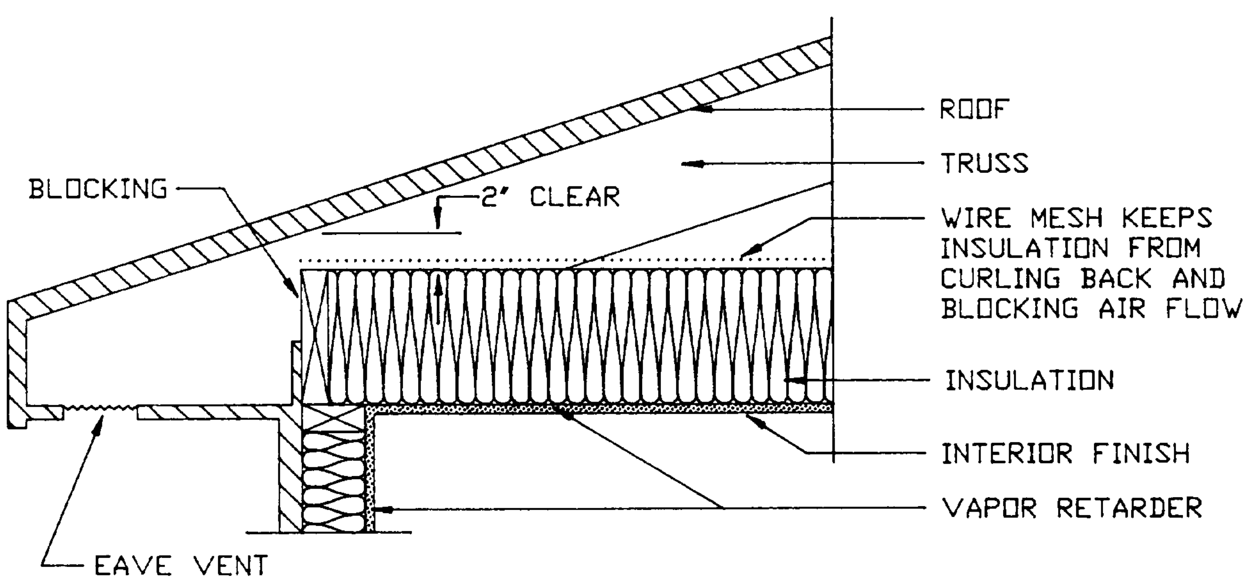


Figure 2-8. Cold attic with insulation on ceiling.

vapor retarder. Primarily, this occurs because it is impossible to obtain a 100 percent vapor seal and a continuous small amount of vapor escapes through tiny gaps, cracks, and holes in the insulated ceiling. Eave and ridge vents should he provided for roofs having cold attic spaces (see figures 2-8 and 2-9). Buildings in areas having frequent high winds and powdery drifting snow, however, should have insulation installed directly under the roofing material; in this case, no eave or ridge vents are permitted. Ventilation should be provided between the insulation and the built-up roofing by using ribbon or spot mopped base sheet, ventilation sheet or kerfed plywood with venting provided under the metal flashing at the eaves or parapets. This allows release of vapor laden air and prevents air pressure buildup underneath the roofing.

(2) *Mechanical ventilation for equipment and occupant&* Louvers and/or fans are normally used in connection with mechanical ventilation necessary to protect equipment and occupants in the buildings. Louvers and fans should be protected with specially designed hoods, as previously described, to decrease air velocity and keep snow from filtering into the building. Because heating and ventilation are so important in cold regions, additional spaces for large heating and ventilating ducts and pipes must be considered. These spaces are generally provided above the ceiling of each story or attic, or below the floors. For additional ventilation discussion, see paragraph 4-3.

2-10. Miscellaneous architectural requirements.

a. Arctic entrance. An arctic entrance is a vestibule used to shut out cold air, high wind, or drifting snow after the exterior door closes and before the inside door is opened. Arctic entrances should also be used in high humidity areas, as discussed in paragraph 2-7*a*. The exterior doors should open inward to preclude blocking by drifting snow and possible damage by high winds. An inswinging door permits burrowing out when blocked, although it violates the fire code for certain occupancies and functions. Each inswinging door requirement must be evaluated separately in terms if risk, alternate exits, and other factors relating to occupant safety. Where drifting snow is not a problem, codes for exit doors should he followed. The floor should be depressed and provided with a grating and pan to allow snow and water removal from footwear. Mats or carpet should be provided at the inside door of the arctic entrance. A canopy should cover the entrance to protect personnel from falling icicles and dripping water. Walkways within 5 feet of exterior building walls should also he protected from falling icicles and water that may freeze, causing a safety hazard. Exterior access ramps for use by the handicapped shall be covered. Otherwise, design for the handicapped shall conform to current criteria.

b. Finish floor elevation. Except for ventilated floors, the floor elevation should be at least 6 inches to 1 foot above the finish grade around the building to eliminate the possibility of water backing up into the building during thaw periods. In extremely flat terrain and where snow drifting is anticipated, the higher elevation may be justified. A stoop should be provided at all exterior doorways other than emergency exits. If a stoop is provided for an outward swinging door, it should be depressed 6 inches below the floor elevation to allow the door to swing above ice and snow.

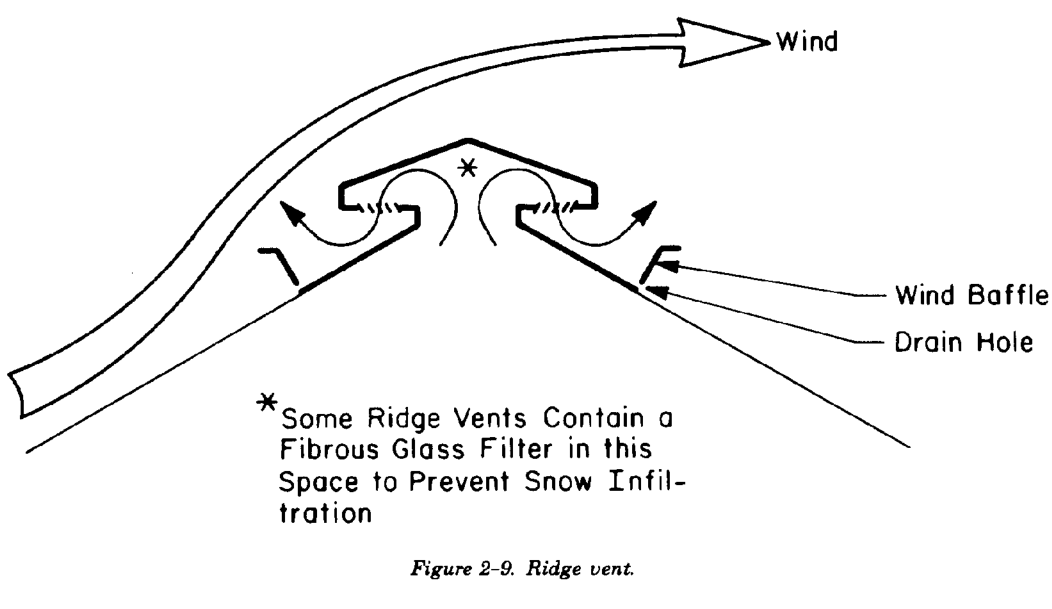


Figure 2-9. Ridge vent.

c. Exterior landings, stairs, and railings. To prevent ice and snow accumulation on horizontal surfaces, open grating type materials should be used for walking surfaces on exterior landings and stairs. Wooden railings or railings provided with rubberized coverings should be considered instead of metal for exterior installation to avoid possible frostbite or bonding of bare skin to metal. Interior or enclosed stairways are preferable. Exterior stairs and landings should be hinged at the building or cantilevered from it to allow for movement from frost heave. If differential heave is anticipated, large landing structures or docks should be isolated from the main structure. Proper foundation treatment may minimize differential movement between warm and cold structures.